Appl. No.: 10/706,480
Amdt. dated 10/26/2005
Reply to Official Action of July 26, 2005

REMARKS/ARGUMENTS

Applicants appreciate the thorough examination of the present application, as evidenced by the first Official Action. Following Applicants' Preliminary Amendment of September 20, 2004, the present application includes currently pending Claims 1, 3-6, 8-11, 13-16 and 18-20. The first Official Action rejects Claims 1, 3, 5, 6, 8, 10, 11, 13, 15, 16, 18 and 20 under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 6,199,745 to Campbell et al. The first Official Action also rejects Claims 1, 3, 4, 6, 8, 9, 11, 14, 16, 18 and 19 under 35 U.S.C. § 102(e) as being anticipated by U.S. Patent No. 6,742,696 to Thompson. In addition, the first Official Action rejects all of the pending claims under 35 U.S.C. § 102(e) as being anticipated by U.S. Patent Application Publication No. 2005/0001010 to Koga et al. Finally, the first Official Action rejects Claims 1, 3, 6, 8, 11, 13, 16 and 18 under 35 U.S.C. § 102(e) as being anticipated by either U.S. Patent No. 6,708,865 to Yoshinaga or U.S. Patent Application Publication No. 2004/0173663 to Okamoto et al. As explained below, however, Applicants respectfully submit that the claimed invention is patentably distinct from the cited references, taken individually or in combination, and accordingly traverses the rejection of the claims as being anticipated thereby. In view of the following remarks, Applicants respectfully request reconsideration and allowance of all of the pending claims of the present application.

In accordance with one aspect of the claimed invention of the present application, as currently recited by independent Claim 1, a friction stir welding system is provided that includes a friction stir welding (FSW) device and a controller. The FSW device includes an actuator capable of moving a FSW tool relative to a workpiece. In this regard, the actuator comprises a plunge actuator capable of moving the FSW tool along a plunge axis. The controller, in turn, is capable of controlling the FSW device to drive the actuator to move the FSW tool relative to the workpiece such that the FSW tool is capable of performing a friction stir welding operation on the workpiece. The controller is capable of monitoring a torque of the actuator. Accordingly, the controller is capable of controlling the FSW device to drive the actuator such that the torque is maintained within a range about a torque setting. More particularly, the controller is capable of controlling the FSW device such that the plunge actuator is driven to move the FSW tool into further contact with the workpiece when the torque decreases below a range about a plunge

torque setting. Conversely, the controller is capable of controlling the FSW device such that the plunge actuator is driven to move the FSW tool into reduced contact with the workpiece when the torque increases above the range about the plunge torque setting.

Similar to the claimed invention, all of the Campbell patent, Thompson patent, Koga publication, Yoshinaga patent and Okamoto publication disclose friction stir welding systems and methods. In contrast to the claimed invention, however, none of the aforementioned references, individually or in combination, teach or suggest monitoring the torque of a plunge actuator capable of moving the FSW tool along a plunge axis, or accordingly controlling a FSW device such that the plunge actuator is driven to move the FSW tool into further or reduced contact with the workpiece based upon the torque and a range about a plunge torque setting. In this regard, the Campbell patent does disclose an inline torque transducer for actuator control. As disclosed by the Campbell patent, however, the inline torque transducer is included with a spindle drive that rotates a welding probe for performing a welding operation, where the spindle control includes simultaneous torque and RPM control. The Campbell patent therefore discloses controlling the rotational torque of a spindle actuator. In contrast, the claimed invention recites controlling the plunge-axis torque of a plunge actuator.

The Thompson patent discloses controlling a vertical feed motor that moves a spindle in a direction toward a workpiece until a downfeed limit switch indicates that the spindle is in its desired position. In this regard, the downfeed limit switch is disclosed as being any device that provides a feedback signal indicating that the spindle has moved downward to its desired position. During performance of a friction stir welding operation, then, a weld processing force is applied by the spindle to the workpiece to push a respective rotating pin into the workpiece, where the actuators applying at least a portion of the force can be chosen to provide a relatively constant force. The Thompson patent therefore discloses position and force control of actuators, including a vertical speed motor, to thereby control a spindle in performing a friction stir welding operation. The Thompson patent does not disclose, however, controlling a plunge-axis torque of an actuator, whether the vertical feed motor or otherwise, capable of moving a FSW tool into further or reduced contact with a workpiece, in a manner similar to the plunge actuator of the claimed invention.

The Koga publication discloses detecting a load torque necessary to rotate a tool holding jig at a predetermined rotational speed. A signal representative of the load torque is then provided to a control means, which in turn, provides a signal to a tool rotation driving means such that the tool rotation driving means decides the rotational speed and rotational time, and rotates the tool holding jig. In this regard, the load torque is obtained based upon a load current flowing in the rotation driving means. Thus, similar to the Campbell patent, the Koga publication discloses controlling the rotational torque of a spindle actuator, as opposed to controlling the plunge-axis torque of a plunge actuator, as does the claimed invention.

The Yoshinaga patent discloses controlling the current (referred to as a torque current) to a motor rotating a tool to perform a friction stir welding operation. In this regard, during performance of a friction stir welding operation, the current is gradually increased to a point Is as the tool is moved into further contact with a workpiece until a large-diameter portion of the tool reaches the workpiece, at which point the current jumps to point Iα. The current can then be increased to a determined value above Iα, which can be maintained during the friction stir welding operation. Thus, like the Campbell patent and Koga publication, the Yoshinaga patent discloses controlling rotation of a tool to perform a friction stir welding operation, rotation of the tool being controlled by application of current to the motor providing such rotation in the Yoshinaga system. Again, in contrast, the claimed invention controls plunge-axis torque of a plunge actuator to drive a tool into further or reduced contact with a workpiece.

Finally, the Okamoto publication discloses controlling a tool to perform a friction stir welding operation based upon the insertion depth of the tool or a load factor associated with the spindle motor driving rotation of the tool. In this regard, the load factor of the spindle motor can be determined as a percentage of the maximum current output to the spindle motor for rotating the tool during a friction stir welding operation. Thus, the Okamoto publication discloses controlling the tool based upon a load factor related to current output to a spindle motor, or based upon an insertion depth of the tool, in contrast to the claimed invention monitoring torque and controlling an actuator to drive a tool into further or reduced contact with a workpiece based thereon.

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To further illustrate distinctions between the claimed invention and the cited references, reference is made to the figure below. As shown, the Campbell patent, Koga publication, Yoshinaga patent and Okamoto publication all appear to disclose friction stir welding systems and methods that control a rotational torque or torque current of the spindle of a friction stir welding tool to thereby control the insertion depth of the tool. In a manner corresponding to the present invention, such a rotational torque would be controlled by controlling a spindle actuator. In contrast, the claimed invention controls a plunge-axis torque to control the depth with which the tool is driven into the workpiece. This torque, in contrast to rotational torque, is controlled by controlling a plunge actuator. Thus, even the Campbell patent, Koga publication, Yoshinaga patent and Okamoto publication, which may disclose controlling tool depth, do so based on a wholly different measurement, spindle actuator (i.e., rotational) torque (or even absolute distance) versus plunge actuator (i.e., plunge-axis) torque.

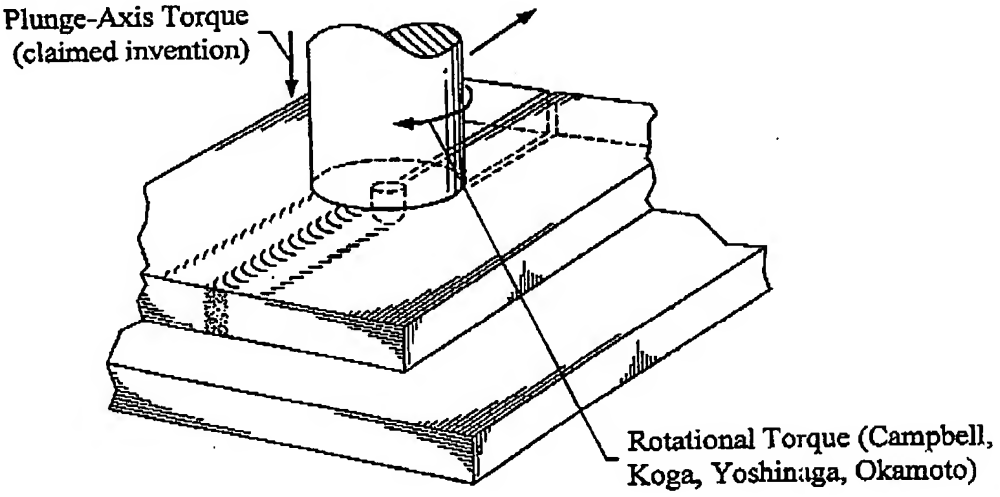

Figure: Comparison of Torque Monitoring/Actuator Controlling

Applicants therefore respectfully submit that the claimed invention of independent Claim 1, and by dependency Claims 3-5, is patentably distinct from the Campbell patent, Thompson

patent, Koga publication, Yoshinaga patent and Okamoto publication, taken individually or in combination. Applicants also respectfully submit that all of independent Claims 6, 11 and 16 recite subject matter similar to independent Claim 1. For example, independent Claims 6, 11 and 16 recite monitoring the torque of a plunge actuator capable of moving the FSW tool along a plunge axis, or accordingly controlling a FSW device such that the plunge actuator is driven to move the FSW tool into further or reduced contact with the workpiece based upon the torque and a range about a plunge torque setting. Accordingly, Applicant respectfully submits that the claimed invention of independent Claims 6, 11 and 16, and by dependency Claims 8-10, 13-15 and 18-20, is patentably distinct from the Campbell patent, Thompson patent, Koga publication, Yoshinaga patent and Okamoto publication, taken individually or in combination, for at least the same reasons given above with respect to independent Claim 1. Applicant therefore respectfully submits that the rejections of Claims 1, 3-6, 8-11, 13-16 and 18-20 under 35 U.S.C. § 102 as being anticipated by one or more of the Campbell patent, Thompson patent, Koga publication, Yoshinaga patent and Okamoto publication is overcome.

CONCLUSION

In view of the remarks presented above, Applicants respectfully submit that the present application is in condition for allowance. As such, the issuance of a Notice of Allowance is therefore respectfully requested. In order to expedite the examination of the present application, the Examiner is encouraged to contact Applicants' undersigned attorney in order to resolve any remaining issues.

It is not believed that extensions of time or fees for net addition of claims are required, beyond those that may otherwise be provided for in documents accompanying this paper. However, in the event that additional extensions of time are necessary to allow consideration of this paper, such extensions are hereby petitioned under 37 CFR § 1.136(a), and any fee required therefore (including fees for net addition of claims) is hereby authorized to be charged to Deposit Account No. 16-0605.

Respectfully submitted,

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CERTIFICATION OF FACSIMILE TRANSMISSION

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Sarah B. Simmons — October 26, 2005
Sarah B. Simmons — Date